WE CLAIM:

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A process for depositing a nanocrystalline diamond film with a grain size between 1 and 100 nm on a surface of a substrate, which comprises:

(a) providing a plasma generating apparatus for depositing the diamond film on the substrate from the plasma including a plasma source employing a radiofrequency, including UHF or microwave, wave coupler means which is metallic and in the shape of a hollow cavity and which is excited in a TM mode of resonance and optionally including a static magnetic field around the plasma which aids in coupling radiofrequency energy at electron cyclotron resonance and aids in confining ions in the plasma in an electrically insulated chamber means in the coupler means, and wherein the chamber means has a central longitudinal axis in common with the coupler means and is mounted in closely spaced and sealed relationship to an area of the coupler means with an opening from the chamber means at one end; gas supply means for providing a gas which is ionized to form the plasma in the chamber means, wherein the radiofrequency wave applied to the coupler means creates and maintains the plasma around the central longitudinal axis in the chamber means; movable metal plate means in the cavity mounted in the coupler means perpendicular to the central longitudinal axis and movable along the central longitudinal axis towards and away from the chamber means; and a movable probe means connected to and extending inside the coupler means for coupling the

radiofrequency waves to the coupler means;

(b) providing the substrate, wherein the surface to be placed in the plasma has been roughened and cleaned; and

(c) providing the substrate in the insulated chamber on a substrate holder adjacent to the plasma generated in the chamber, wherein the gas in the chamber is at a pressure between 50 and 300 Torr in the presence of the radiofrequency waves for generating the plasma, wherein the gas is ninety percent by volume or more of argon along with methane and optionally hydrogen and essentially without oxygen or nitrogen and wherein the chamber is essentially free from leaks of nitrogen or oxygen or mixtures thereof into the chamber, so as to generate the plasma and to deposit the nanocrystalline diamond film on the substrate.

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The process of Claim 1 wherein the substrate has a dimension with a surface area greater than about 20 cm^2.

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The process of Claim 1 or 2 wherein the microwave is at 2.45 GHz.

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The process of Claim 1 or 2 wherein the microwave is at 915 MHz.

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The process of Claim 1 or 2 wherein the film has a thickness of at least about 50 nm micrometers.

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A nanocrystalline film prepared by the process of Claim 1.

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A nanocrystalline film prepared by the process of Claim 2.

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The process of Claim 1 wherein the substrate is allowed to thermally float at a temperature between about 575°C and 900°C on a side exposed to the plasma.

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The process of Claim 1 wherein diamond particles are used for providing the roughened surface by abrasion and wherein the diamond particles have a grain size between about 0.1 to several micrometers, which surface is then cleaned.

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The process of Claim 1 wherein the pressure on the gas is between about 60 and 240 Torr and at a flow rate of between about 50 and 200 sccm.

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The process of Claims 1 or 2 wherein the probe means is elongate and is mounted in the coupler means along the central longitudinal axis of the chamber means and coupler means with an end of the probe means in spaced relationship to the chamber means; and wherein stage means in the opening of the chamber which forms part of the cavity and provides for mounting the substrate, the stage means having a support surface which is in a plane around the longitudinal axis and which is pre-adjusted towards and away from the plasma in the chamber means so that the substrate can be coated with the diamond film from the plasma.

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The process of Claims 1 or 2 wherein the insulated chamber is evacuated so that there is less than about 10 ppm of combined oxygen and nitrogen or nitrogen or oxygen alone as the gas which generates the plasma is provided in the chamber.

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The process of Claims 1 or 2 wherein the substrate is silicon and wherein the substrate holder is molybdenum.

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The process of any one of Claims 1 or 2 wherein the substrate on which the diamond is deposited has a surface area with a diameter which is greater than about 8 cm.

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The process of Claim 1 wherein the gas contains about 1% methane.

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The process of Claim 1 wherein the mode of the plasma is selected from the group consisting of TM012 and TM013.

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The process of Claim 1 wherein at pressures of greater than about 250 Torr the stage means can be optionally cooled.

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The process of Claim 1 wherein the substrate is a silicon carbide seal and the holder is molybdenum which shields a first portion of the seal while allowing a portion of the seal to be coated with the nanocrystalline diamond.